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NOTES AND LITERATURE

GENERAL BIOLOGY

Mendelism.[1] — In a well printed booklet of eighty-five 4 × 5½ inch pages, R. C. Punnett of Cambridge, England, has presented an admirably clear and concise account of Mendelism. After reviewing the simple and fundamental experiments of the Abbot of Brünn, the writer describes the more recent discoveries to which they have led, and in conclusion shows them to be of the highest practical and scientific importance. Although the mendelian principles of heredity are well known in America through the publications of Castle, Davenport, and others, a brief review of them as presented by Punnett may still be of interest.

It is found by experiment that when a certain pure bred tall variety of plant is crossed with a dwarf, the resulting hybrid contains both the factors for tallness and shortness. If A represents the tall factor of one parent and a the short factor of the other the hybrid which contains both is Aa. It is not of medium height, but is like its tall parent. A character such as tallness in peas which is retained by the hybrid is called *dominant*: one like dwarfness which is latent in the hybrid is named *recessive*.

When hybrids Aa are bred together, they produce in the next generation 25% of pure tall forms, AA; 50% of tall hybrids, Aa; and 25% of dwarfs, aa. The familiar formula may be written thus:

$$\begin{array}{lc} \text{Parents} & \underbrace{AA \qquad\quad aa} \\ \text{1st generation} & Aa \\ \text{2nd generation} & \overbrace{AA \qquad 2\,Aa \qquad aa} \end{array}$$

The tall hybrids Aa, and the pure tall plants AA, are indistinguishable except by further breeding. Then it appears that one in every three contains only the factors for tallness. Such plants, like the dwarfs, breed as true as if derived from an unbroken ancestry of pure forms.

It is not always the case that the hybrid resembles one of its parents.

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[1] Punnett, R. C. *Mendelism.* Second Edition. Cambridge, MacMillan and Bowes, 1907. 16mo. vii + 85 pp.

The blue Andalusian fowl is a race which in breeding produces 25% of black offspring, 50% of blue, and 25% of white splashed with black. It is evident from these proportions that the blue race desired by fanciers is essentially mongrel, and can never be made to breed true. The black race and the splashed whites remain true when each is mated with its own kind, but when crossed they produce the blue Andalusian.

The fixed proportion of pure and mongrel forms in the offspring of hybrids may be readily explained. The factors *A* and *a*, derived by the hybrid from its parents respectively, are transmitted through its germ cells in equal abundance. The factors become segregated, so that one half of the germ cells contains only *A*, and the other half *a*. In the process of fertilization an *A* will unite with *a* as often as with *A*; and an *a* will join *A* as often as *a*. Thus there will be 2 *Aa* for each *aa* and *AA*.

When two different inheritable factors occur in each parent the number of combinations in the offspring is much greater. Mendel found, with peas, that the height of the plant (tall or dwarf) and the color of the seeds (green or yellow) were transmitted independently of one another. *A* and *B* may represent respectively the factors for tallness and greenness which are dominant; *a* and *b* the factors for shortness and yellowness which are recessive. If a tall green-seeded plant *AB*, is crossed with a dwarf yellow *ab*, tall green-seeded hybrids containing the factors *AaBb* result. Every germ cell of such a hybrid contains one factor for height and one for color; they are equally distributed in the four possible combinations *AB*, *Ab*, *aB*, and *ab*. When such a group of germ cells fertilizes a similar group, the following combinations are to be expected:

AA BB	*AA bb*	*aa BB*	*aa bb*
2*AA Bb*	2*Aa bb*	2*aa Bb*	
2*Aa BB*			
4*Aa Bb*			

Thus among sixteen individuals nine contain both dominant factors and in the case of the peas are tall green-seeded plants. Three contain only the dominant *A*, and are tall yellow-seeded forms; three contain only the dominant *B* and are green-seeded dwarfs. One contains neither dominant and is a yellow-seeded dwarf. This ratio, 9:3:3:1 Mendel verified by experiment.

The sweet pea known as the 'Painted Lady' has a bright pink color due to its sap, and this is dominant over the absence of such sap color in which case the flower is white. In the cream sweet pea there is no sap color, the tint being due to pigmented chromoplasts. The yellow chromoplasts are recessive to colorless ones. Therefore when a Painted Lady is crossed with a cream, the hybrids are all Painted Ladies; in the next generation four classes are found,— Painted Ladies, cream Painted Ladies, whites, and creams, in the proportion 9:3:3:1.

A similar result has been observed in breeding fowls. The rose comb of the Wyandotte type and the pea comb of the Indian game are both dominant over the single comb of the Leghorn type. When a rose comb is crossed with a pea comb a new type results, described as the "walnut" comb. It resembles that of the Malay breed. When such hybrids are bred together four types of comb appear in the next generation, namely the walnut, rose, pea, and single in the proportion of 9:3:3:1.

In rabbits the gray color of the wild animal is dominant over albinism. When a gray is crossed with an albino, gray hybrids result which produce young in the proportion of 9 grays, 3 blacks, and 4 whites. The factors involved are pigmentation, A, dominant over albinism, a; and grayness, B, dominant over blackness, b. The four white animals which appear identical include three forms, namely $aa\ BB$, 2 $aa\ Bb$, and $aa\ bb$, all of which lack the pigmentation factor A. From this it appears that the wild gray color consists of a factor for pigmentation and another for grayness. By loss of the former a white rabbit results, and by loss of the latter, a black one. In the offspring of such a white and black, *reversion* occurs to the original gray form. Similarly white pea blossoms may each contain one of the two factors for pigmentation, and by crossing such whites, reversion to a wild colored type has been observed. Thus reversion has been defined as a union of complementary factors which have become separated in the course of phylogenetic development.

From these and many other observations, the author concludes that no horticulturalist can propose to raise a tall pea from a dwarf by a process of manuring, nor by selecting minute fluctuations, but only by obtaining new aggregations of unit characters through breeding. He infers that "education is to man what manure is to the pea." — "Permanent progress is a question of breeding rather than of hygiene and pedagogics" for "the creature is not made but born."

In Mr. Punnett's book no reference is made to 'mixed inheritance' whereby the parental characters are blended in the offspring. It must be remembered, however, that rabbits with ears of medium length are obtained by crossing short-eared with lop-eared forms; and that the crossing of some tall and dwarf plants produces those of intermediate height. The omission of such limitations may cause a student to believe that Mendelism is the universal law of inheritance.

F. T. L.

The Problem of Age, Growth, and Death.— In a series of six public lectures Professor Charles S. Minot has made known the results of his studies, now in progress, concerning the essential nature of senescence. Rejecting such criteria of old age as a halting gait or arterio-sclerosis, which pertain chiefly to man, he has sought those features which apply as well to the aged frog or fish, and even to still lower forms. Such characteristics are found in the decreasing rate of cell division, the increase of protoplasm at the expense of the nucleus, and the progressive differentiation of the protoplasm. Old age is therefore essentially a cytomorphic phase.

The rate of cell division is expressed by the "*mitotic index*" which is the average number of mitotic figures found, in sections, among a thousand nuclei. The mitotic index falls from 18 to 13 in rabbit embryos of 7½ and 13 days respectively. Drawings, on the same scale, of nuclei of the various tissues in rabbit embryos of 7½ to 16½ days show a striking reduction in the actual size of the nucleus, except in the case of the nervous tissue. Even there, in relation to the protoplasmic mass, the nucleus may be relatively small.

The rate of growth begins to decline before birth, and this rate of decline rapidly *decreases* until old age, when growth is at its minimum. The uninterrupted process of senescence was demonstrated by weighings of rabbit embryos of various ages, and of individual guinea pigs, rabbits and chickens, from birth until death. The same law was held to apply to man, both in physical development as shown by statistics of weight, and in mental development as determined by psychologists. During the first months after birth, progress in acquiring concepts of time, space, the ego, and the external world is more rapid than in later years. As with weight, the rate of decline is most abrupt at the outset, becoming gradual as age advances.

The study leads to the paradoxical conclusion that the changes of senescence are most marked in the years of infancy, for the popular idea of maximum efficiency as the mark of maturity is set aside. The embryo in adding an ounce to its weight is rated as advancing more rapidly than the child in gaining a pound; the insect which leaps many times its own length would be regarded as more successful in jumping than the mammal which can far outdistance it.